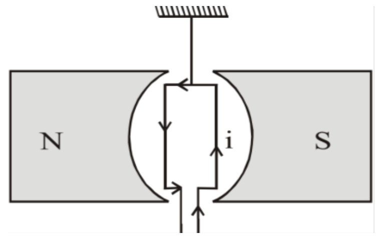
MOVING COIL GALVANOMETER

A galvanometer, designed to identify current, possesses a moderate level of resistance.



Principle

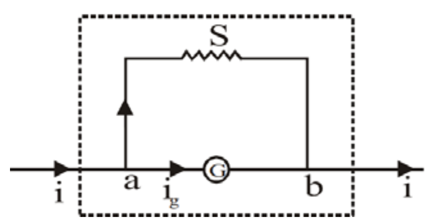
When a coil carrying an electric current is positioned in a magnetic field, it undergoes torque as expressed by $\tau = NiAB \sin\theta$ where θ is The angle between the normal to the coil's plane and the direction of the magnetic field is the actual configuration, where the coil is suspended amid the cylindrical pole pieces of a robust magnet.

The cylindrical pole pieces create a radial magnetic field, ensuring that $\sin\theta$ is always equal to 1. Thus, the torque is $\tau = NiAB$ If C is torsional rigidity (i.e., restoring couple per unit twist of the suspension wire), then for deflection θ of coil $\tau = C\theta$ in equilibrium we have external couple = Restoring couple i.e. NiAB or $\theta = \frac{NAB}{C}$ i i.e., $\theta \propto i$

In simple terms, the deflection observed is directly proportional to the current flowing through the coil. The quantity $\frac{\theta}{i} = \frac{NAB}{C}$ It is referred to as the current sensitivity of the galvanometer. Naturally, for increased sensitivity of the galvanometer, the number of turns (N), the coil's area (A), and the magnetic field (B) generated by the pole pieces should be greater, while the torsional rigidity (C) should be smaller. This is why a suspension wire made of phosphor bronze, with lower torsional rigidity (C), is utilized.

Conversion of Galvanometer into Ammeter

An ammeter is essentially a galvanometer with low resistance, employed for the direct measurement of current in amperes. It is invariably linked in series with the circuit. To transform a galvanometer into an ammeter, a low-resistance component, known as a shunt, is connected in parallel with the galvanometer, as depicted in the figure.



Consider i_g as the current causing full-scale deflection in the galvanometer, and G as the galvanometer's resistance. Let i_s represent the ammeter's range, and S denote the current flowing through the shunt. In this scenario, the potential difference across points a and b is calculated as follows:

$$V_{ab} = i_o G = i_s S \quad \ldots (1)$$

At junction a, $i = i_s + i_g$ i.e., $i_s = i - i_g$

Therefore from (i) $i_g G = (i - i_g)S$ or $i_g(S + G) = iS$ i.e., $i_g = \frac{S}{S+G} i$ ... (2)

This equation serves as the operational formula for transforming a galvanometer into an ammeter $i_g < i$

From (2) shunt required $S = \frac{i_g G}{i - i_g}$. If $i_g \ll i$, $S = (\frac{i_g}{i})G$

The resistance of ammeter R_A so formed is given by $\frac{1}{R_A} = \frac{1}{G} + \frac{1}{S} \Rightarrow R_A = \frac{SG}{S+G}$ ... (3)

Note Equation (2) can also be utilized to extend the range of a provided ammeter. In this case, G represents the resistance of the given ammeter, S is the shunt applied, i_g denotes its initial range, and i is the desired new range.

Conversion of Galvanometer into Voltmeter

A voltmeter is essentially a galvanometer with high resistance, linked between two points to measure potential difference; hence, it is connected in parallel with the circuit. To adapt a galvanometer into a voltmeter, a high resistance (R) is connected in series with the galvanometer.

If V is range of voltmeter, then $i_g = \frac{V}{R+G}$ or resistance in series $R = \frac{V}{i_g} - G$ ... (1)

This is the operational formula for transforming a galvanometer into a voltmeter.

The resistance of voltmeter so formed is $R_V = R+G$ ... (2)

Note: Equation (i) may also be used to increase the range of voltmeter. If V0 is initial range and V is new range of voltmeter, then $i_g = \frac{V_0}{G} = \frac{V}{R+G}$.